# REPORT

OF THE

# BOMBAY BACTERIOLOGICAL LABORATORY

## FOR THE YEAR 1914

BY

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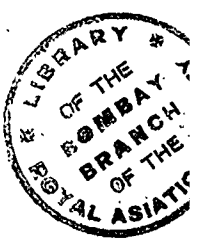
*Director, Bombay Bacteriological Laboratory.*

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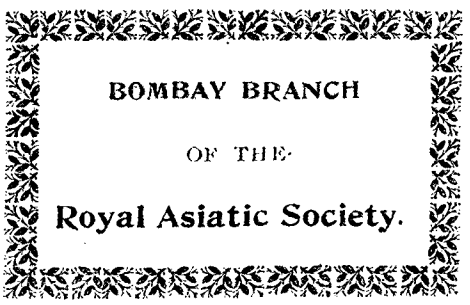


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# REPORT OF THE BOMBAY BACTERIOLOGICAL LABORATORY FOR THE YEAR 1914.

## STAFF.

Staff.

1. The Director of the Laboratory was Major Wm. Glen Liston, C.I.E., M.D., D.P.H., I. M. S., throughout the year.

The Assistants to the Director were :—

(*a*) Major T. H. Gloster, M.B., D.P.H., I. M. S., from January to 12th June 1914 when he proceeded on leave and from 11th September to 17th October 1914; transferred to Military duty thereafter.

(*b*) Captain J. Taylor, M.D., D.P.H., I. M. S., acted as Assistant to the Director in place of Captain W. D. H. Stevenson, I. M. S., on leave from January to 4th September 1914.

(*c*) Captain W. D. H. Stevenson, M.D., D.P.H., I. M. S., returned from leave on the 5th September 1914 and was Assistant to the Director until the end of the year.

(*d*) Dr. D. A. Turkhud, M.B., C.M. (Edin.), Special Officer, was attached to the Laboratory during the entire year.

## ARRANGEMENT OF THE REPORT.

2. The report is divided into two parts setting forth under separate heads the work done :

(*a*) as the Laboratory where all the anti-plague vaccine used in India and its dependencies is made, and where investigations connected with plague are carried out ; and

(*b*) as the Bombay Bacteriological Laboratory where work connected with preventive medicine and pathological diagnosis for the whole of the Bombay Presidency is carried out.

## PART I.

### Work connected with Plague.

#### (*a*) Routine Work.

Output in doses of anti-plague vaccine for the past 5 years.

3. The table below gives comparative figures of output in doses of anti-plague vaccine for the past five years :—

| 1910. | 1911. | 1912. | 1913. | 1914. |
|---|---|---|---|---|
| 625,690 | 1,211,170 | 727,377 | 795,637 | 812,942 |

This table and the following statement show that the number of doses of anti-plague vaccine despatched from the Laboratory this year has been larger than in any previous year except the year 1911. The increase in the demand for the plague vaccine was especially marked in Bengal, Behar and Assam; United Provinces; the Punjab; Central Provinces and Berar; Burma; and the Native States of India. A marked decrease in the demand for vaccine was noted in the Bombay and Madras Presidencies this year as compared with previous years.

Since the Laboratory was opened in 1896 up to the end of 1914 the total number of doses sent out has been 12,242,796.

The distribution of anti-plague vaccine.

The distribution of anti-plague vaccine in India and foreign countries during the last two years is shown below (figures represent number of doses) :—

| Place or Province. | 1913. | 1914. |
|---|---|---|
| Bombay Presidency and Sind ... ... ... | 220,575 | 96,217 |
| Madras Presidency ... ... ... ... | 119,460 | 43,375 |
| Bengal, Behar and Assam ... ... ... ... | 12,800 | 46,115 |
| United Provinces of Agra and Oudh ... ... ... | 126,192 | 205,425 |
| The Punjab ... ... ... ... | 46,800 | 91,750 |
| North-West Frontier Province ... ... ... | 1,170 | 2,110 |
| Central Provinces and Berar ... ... ... | 13,060 | 24,175 |
| Burma ... ... ... ... | 40,200 | 50,000 |
| Native States in India ... ... ... ... | 62,255 | 107,050 |
| Countries outside India ... ... ... ... | 152,625 | 146,650 |
| Portuguese Territory in India ... ... ... | 500 | 75 |
| Total number of doses ... | 795,637 | 812,942 |

The monthly despatch was as follows :—

| Month. | 1913. | 1914. |
|---|---|---|
| January ... ... ... ... ... | 46,315 | 125,885 |
| February ... ... ... ... ... | 61,760 | 119,300 |
| March ... ... ... ... ... | 56,896 | 75,501 |
| April ... ... ... ... ... | 52,010 | 33,566 |
| May ... ... ... ... ... | 8,185 | 16,095 |
| June ... ... ... ... ... | 8,475 | 4,705 |
| July ... ... ... ... ... | 20,140 | 5,655 |
| August ... ... ... ... ... | 131,775 | 65,495 |
| September ... ... ... ... ... | 124,015 | 27,180 |
| October ... ... ... ... ... | 151,165 | 128,180 |
| November ... ... ... ... ... | 93,116 | 88,615 |
| December ... ... ... ... ... | 41,785 | 122,765 |
| Total number of doses ... | 795,637 | 812,942 |

## *Statistics of inoculation.*

Statistics of inoculation.

4. As usual a letter was addressed to all officers to whom anti-plague vaccine had been sent during the year asking them to favour us with any statistics they might be able to supply which showed the effect of inoculation on a plague epidemic. Although a large number of officers were kind enough to supply us with figures the majority of the statistics submitted were defective in one or more points of detail. We have not reproduced these statistics for this reason, although all show that the inoculated suffered less severely from plague than the uninoculated and that by adopting this measure for combating plague many lives were saved.

We reproduce below, however, some carefully compiled statistics from among certain small communities which show the value of inoculation in markedly lessening the incidence and mortality from plague. These statistics have been collected by Assistant Surgeon P. B. Potnis on Inoculation duty in the Dhárwár District and deal with epidemics which occurred in the villages of Shirol, Kurtakotti, Nargund, Konnur, Bankutty, Namally, Shalwadi, Madgunki and Amingeri.

Bombay Presidency, Dhárwár District.

Statistics comparing the effect of plague on inoculated and uninoculated persons in certain villages of the Dhárwár District:—

| Names of Villages. | Number of houses. | Number of persons living in these houses. | Distribution according to sex and age. | Inoculated. | | | | | | | | | Uninoculated. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Sex. | | Age-periods. | | | | | | | Sex. | | Age-periods. | | | | | |
| | | | | Males. | Females. | 1—10. | 11—20. | 21—30. | 31—40. | 41—50. | 51 and upwards. | Total. | Males. | Females. | 1—10. | 11—20. | 21—30. | 31—40. | 41—50. | 51 and upwards. | Total. |
| Shirol ... | 7 | 48 | Number ... | 22 | 0 | 5 | 6 | 9 | 2 | 0 | 0 | 22 | 8 | 18 | 5 | 8 | 5 | 3 | 3 | 2 | 26 |
| | | | Attacks ... | 0 | 0 | 0 | 0 | 2 | | 0 | 0 | 2 | 0 | 0 | 1 | 3 | 1 | 0 | 1 | 1 | 7 |
| | | | Deaths ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 1 | 0 | 1 | 1 | 7 |
| Kurtakotti ... | 4 | 29 | Number ... | 9 | 7 | 5 | 4 | 2 | 3 | 2 | 0 | 16 | 4 | 9 | 3 | 3 | | 0 | 2 | 3 | 13 |
| | | | Attacks ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 4 |
| | | | Deaths ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 4 |
| Nargund ... | 42 | 173 | Number ... | 65 | 28 | 23 | 25 | 30 | 9 | 5 | 1 | 93 | 37 | 43 | 16 | 24 | 14 | 7 | 11 | 8 | 80 |
| | | | Attacks ... | 0 | 0 | 3 | 2 | 3 | 1 | 0 | 0 | 9 | 0 | 0 | 3 | 14 | 3 | 1 | 6 | 4 | 31 |
| | | | Deaths ... | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 11 | 2 | 1 | 2 | 2 | 20 |
| Konnur ... | 20 | 96 | Number ... | 31 | 4 | 11 | 13 | 5 | 3 | 1 | 2 | 35 | 29 | 32 | 12 | 10 | 16 | 10 | 4 | 9 | 61 |
| | | | Attacks ... | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 5 | 5 | 8 | 3 | 3 | 1 | 25 |
| | | | Deaths ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 3 | 6 | 2 | 2 | 1 | 18 |
| Bunkutty ... | 6 | 24 | Number ... | 11 | 5 | 9 | 2 | 2 | 2 | 1 | 0 | 16 | 1 | 7 | 1 | 3 | 3 | 1 | 0 | 0 | 8 |
| | | | Attacks ... | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 4 |
| | | | Deaths ... | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| Namally ... | 3 | 11 | Number ... | 5 | 0 | 1 | 2 | 1 | 1 | 0 | 0 | 5 | 3 | 4 | 1 | 2 | 2 | 1 | 0 | 0 | 6 |
| | | | Attacks ... | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 2 |
| | | | Deaths ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 2 |
| Shaiwadi ... | 8 | 41 | Number ... | 10 | 1 | 2 | 0 | 8 | 0 | 1 | 0 | 11 | 9 | 21 | 8 | 7 | 5 | 5 | 3 | 2 | 30 |
| | | | Attacks ... | 0 | | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 2 | 2 | 0 | 0 | 0 | 7 |
| | | | Deaths ... | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 3 |
| Madgunki ... | 4 | 23 | Number ... | 11 | 5 | 5 | 5 | 3 | 2 | 1 | 0 | 16 | 2 | 5 | 1 | 2 | 3 | 0 | 1 | 0 | 7 |
| | | | Attacks ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 1 | 2 | 1 | 0 | 0 | 0 | 4 |
| | | | Deaths ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 0 | 0 | 0 | 4 |
| Amingeri ... | 37 | 210 | Number ... | 73 | 24 | 23 | 29 | 16 | 12 | 13 | 2 | 97 | 54 | 59 | 27 | 23 | 17 | 14 | 8 | 24 | 113 |
| | | | Attacks ... | 0 | 0 | 5 | 5 | 2 | 0 | 2 | 0 | 14 | 0 | 0 | 5 | 9 | 7 | 5 | 0 | 6 | 32 |
| | | | Deaths ... | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 7 | 7 | 2 | 0 | 6 | 24 |
| Total ... | 131 | 655 | Number ... | 237 | 74 | 87 | 83 | 76 | 34 | 23 | 5 | 311 | 146 | 198 | 74 | 82 | 67 | 41 | 32 | 48 | 344 |
| | | | Attacks ... | 26 | 8 | 9 | 13 | 9 | 1 | 2 | 0 | 34 | 41 | 75 | 19 | 40 | 24 | 9 | 11 | 13 | 116 |
| | | | Deaths ... | 3 | 4 | 2 | 2 | 3 | 0 | 0 | 0 | 7 | 29 | 55 | 14 | 30 | 18 | 5 | 6 | 11 | 84 |
| Percentage of | ... | ... | Attacks ... | 10 | 10·8 | 10 | 15 | 12 | 3 | 9 | 0 | 10·9 | 28 | 37 | 25 | 48 | 35 | 22 | 34 | 27 | 33·7 |
| | | | Deaths ... | 11·5 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 2·2 | 70 | 73 | 0 | 0 | 0 | 0 | 0 | 0 | 24·1 |

In almost all these villages many people left their houses when plague broke out; a certain number of persons, however, remained in the villages throughout the epidemic. In certain households all the inmates were inoculated, in certain other households none were inoculated. None of these households have been taken into consideration in the statistics detailed above. Only those houses in which inoculated persons were living together with uninoculated persons have been considered and moreover of these houses only those have been considered in which plague cases occurred at some date subsequent to the day on which the last person was inoculated in that house. We hoped in this way to exclude any influence which social status or habits might have on the prevalence of the disease and by taking into consideration only those houses in which plague appeared subsequent to inoculation we made more

certain that the inoculated were subjected to the same chance of infection as the uninoculated. Despite these precautions, however, there remained the possibility that the inoculated group did not exactly correspond to the uninoculated group. It was possible for example that owing to timidity or other cause the females might not be inoculated so frequently as the males or again that the age distribution in the two groups might not be exactly comparable. A careful house-to-house inquiry at the end of the epidemic was, therefore, made in each village ; the name, age, and sex of every person who had lived in the village during the epidemic was recorded and the fact was noted whether each person had or had not been inoculated or had suffered or died from plague.

Selecting the houses in all the villages in the manner mentioned above 131 households containing 311 inoculated and 344 uninoculated persons were available for the purpose of the present inquiry. Among the 311 inoculated persons there were 34 attacks and 7 deaths while among the 344 uninoculated there were 116 attacks and 84 deaths. The percentage incidence of the disease among the inoculated was thus 10·9 while among the uninoculated it was 33·7. The death-rate among the inoculated was 2·2 per cent. while the uninoculated had a death-rate of 24·4 per cent.

A further analysis of the figures showed that the two groups were not quite comparable in regard to sex and age distribution. Thus it will be seen from the table that among the inoculated there were 237 males and 74 females while among the uninoculated there were 146 males and 198 females. This difference in the distribution of sexes becomes of importance when it is noted that the incidence of the disease among the uninoculated females was 37 per cent. as compared with 28 per cent. among the males, showing that the females were more liable to contract infection. The sex distribution in the two groups is thus in favour of the inoculated group but even if allowance is made for this difference in the two groups inoculation had reduced the incidence of the disease nearly threefold. While the incidence of the disease was greater among the uninoculated females than among the males the case mortality rate in the two sexes was only slightly different being 73 per cent. of the uninoculated females and 70 per cent. of the uninoculated males.

The age distribution in the two groups differs mainly in respect that among the uninoculated the number of persons over forty is considerably larger than the number of the same age periods among the inoculated. At the lower ages, especially at the age periods 11—20 and 21—30, the inoculated are more numerous than the uninoculated. This uneven age distribution among the two groups favours the uninoculated, for the incidence of the disease is greatest at the age periods 11—20 and 21—30. From the table it will be seen that while the incidence of the disease among the uninoculated at all ages was 33·7 per cent. the incidence was greater than this mean figure at the age periods 11—20, 21—30 and 41—50, the percentage incidence at these ages being respectively 48, 35 and 34. At the age periods 1—10, 31—40 and 51 and upwards the percentage incidence among the uninoculated was 25, 22 and 27. We can divide the inoculated and uninoculated members of these households each into two groups according as they belonged to age periods more or less prone to infection as shown by the figures above. If this is done then we find among the inoculated 185 persons belonging to the more severely infected age periods and 126 to the less severely infected age periods. The corresponding figures among the uninoculated are 181 and 163 respectively, on the whole therefore any disparity in the age distribution of the two groups favoured the uninoculated though only to a very small extent.

Without taking into consideration the sex and age differences in the constitution of the two groups we can calculate that if the inoculated had suffered to the same extent as the uninoculated they should have had 104 attacks in place of 34 only. If a correction is made for the larger number of males among the inoculated as compared with the uninoculated we might have expected the inoculated to have had 94 attacks in place of 34 only. If a correction is made for the disparity in the age distribution in the two groups, the inoculated might have been expected to have had 106 attacks in place of

34 only. We may conclude then that the uninoculated were attacked three times more frequently than the inoculated.

Passing on to consider the case mortality we find that 72 per cent. of the uninoculated who were attacked died while only 20 per cent. of the inoculated who were attacked succumbed to the disease. It has been pointed out that among the uninoculated the case mortality among males and females was approximately 70 and 73 per cent. respectively. When we consider the death rate among the inoculated we have to deal with very small figures but it may be noted that among 26 inoculated males who were attacked, only three died giving a case mortality rate of a little over 11 per cent.; while of eight females attacked as many as four died giving a case mortality rate of 50 per cent. The ages of the inoculated females who died were 21, 13, 7 and 4. Except the female aged 21, who received 3·6 c. c. of the vaccine, the dose of vaccine given to the others was very small. We may calculate that if the inoculated had suffered as severely from plague as the uninoculated they should have had 76 deaths in place of 7 only. But if allowance is made for the difference in the sex constitution of the two groups we might have expected 66 deaths in place of seven only. We will therefore not be far wrong if we say that the inoculated had nearly ten times fewer deaths than the uninoculated.

Having thus taken into consideration only those houses in which inoculated were living beside uninoculated and in which plague cases occurred at some date subsequent to the last inoculation in each house, we find that in these villages in the Dhárwár District in which investigations were made inoculation probably saved sixty lives.

These figures show that the vaccine as at present issued from the Laboratory maintains a high degree of efficiency.

## (*b*) Research Work.

### I.

Experiments to determine whether two small doses of vaccine were as efficient in producing immunity as a single large dose.

5. A number of experiments on rats were made with the object of ascertaining the best method of carrying out inoculation. In previous reports from this Laboratory it has been shown that the practical success of an inoculation campaign depends on two important factors:—

(*a*) the degree of immunity conferred by inoculation; and

(*b*) the reaction (fever, pain at the site of inoculation, etc.) which follows inoculation.

The most successful campaign is that one in which the immunity conferred by inoculation is of a high order and in which, at the same time, the reaction after inoculation is slight. Unfortunately it has been observed that the greatest protection from plague infection has been obtained with vaccine which caused a severe reaction in the doses usually prescribed. The severity of the reaction in these cases has sometimes deterred people from submitting themselves to the operation so that, although the protection conferred on the inoculated is of a high order, fewer persons undergo the operation with the result that in the end fewer lives are saved.

With the object of devising a means for lessening the reaction experiments were made on rats to ascertain whether as great or greater immunity would be conferred on the animals by dividing the dose used into two parts, inoculating one part first and a second part a week later. These experiments showed that the method of using two small doses in place of one large dose conferred greater immunity on rats. Observations on man proved that small doses of a strong vaccine were followed by only a slight reaction and double the original dose administered a week later was tolerated well. When staff and time permit we recommend inoculators to give a small initial dose of from 1 to 2 c. c. of the vaccine (the exact dose being regulated according to age, sex, physical fitness, etc.) to be followed a week later by a second dose of from 2 to 4 c. c. of the vaccine.

Observations on man and experiments on rats show that in this way the severity of the reaction may be lessened and a high degree of immunity obtained. The only drawback to this method of administering the anti-plague vaccine is found in the fact that the repetition of the operation necessitates an increase in the staff required for carrying out the operations and a number of persons will be inadequately protected if they refuse or fail to obtain the second injection.

II.

Experiments to determine the best method of using Hydrocyanic Acid Gas for the destruction of rats and other vermin.

6. During the year further experiments were made with Hydrocyanic Acid Gas for killing rats and other vermin. A number of different methods and machines were devised for generating and diffusing the gas in rooms. Satisfactory progress has been made with these experiments and many of the difficulties encountered have been overcome; we hope to be able to test this method of killing rats on a practical scale in plague-infected villages next year.

III.

The relative proportion of three species of *Xenopsylla* found on rats in Bombay, Coonoor, and Ootacamund.

7. In a January number of the British Medical Journal, page 88, a letter was printed from Dr. Hirst of Colombo in which he stated that an examination of certain fleas caught on rats in Colombo and Madras City showed that they belonged to a species which closely resembled but which was not identical with the common species found on Bombay rats (*Xenopsylla cheopis*). The Honourable N. C. Rothschild named this new species *Xenopsylla astia.*

Dr. Hirst's note does not state what proportion of the fleas found on the rats of Colombo or Madras belonged to this new species but he suggested that the observation might be of importance in explaining the comparative freedom of Madras and Colombo from plague epidemics.

Following the publication of Dr. Hirst's letter an interesting and important paper on "Three Species of Xenopsylla occurring on Rats in India" was published by the Honourable N. C. Rothschild, M.A., F.L.S., in the Bulletin of Entomological Research, Vol. V, Part I. This paper clearly details the differential characters of the three species. Mr. Rothschild remarks: "The three species are very much alike and can only be distinguished with certainty under a good microscope. A hand lens is absolutely useless for the purpose."

A careful examination of fleas caught on rats in Bombay, Coonoor and Ootacamund belonging to the three species of Xenopsylla was made with the following result.

Proportion of *Xenopsylla brasiliensis, cheopis* and *astia* found on the rats in Bombay :—

| | Male. | Female. | Total. | Percentage. |
|---|---|---|---|---|
| X. brasiliensis ... ... | 3 | *Nil.* | 3 | 0·84 |
| „ cheopis ... ... | 126 | 161 | 287 | 80·6 |
| „ astia ... ... | 21 | 45 | 66 | 18·5 |
| Total ... | ..... | ..... | 356 | ..... |

Proportion of *Xenopsylla brasiliensis, cheopis* and *astia* found on the rats at Coonoor :—

| | Male. | Female. | Total. | Percentage. |
|---|---|---|---|---|
| X. brasiliensis ... ... | 62 | 46 | 108 | 11·9 |
| „ cheopis ... ... | 453 | 338 | 791 | 87·5 |
| „ astia ... ... | 2 | 3 | 5 | 0·5 |
| Total ... | ..... | ..... | 904 | ..... |

Proportion of *Xenopsylla brasiliensis, cheopis* and *astia* found on the rats at Ootacamund :—

| | Male. | Female. | Total. | Percentage. |
|---|---|---|---|---|
| X. brasiliensis ... ... | 4 | 5 | 9 | 8·1 |
| „ cheopis ... ... | 43 | 59 | 102 | 91·9 |
| „ astia ... ... | *Nil.* | *Nil.* | *Nil.* | *Nil.* |
| Total ... | ..... | ..... | 111 | ..... |

It is interesting to observe that in all the three places *X. cheopis* constituted the overwhelming majority, over 80 per cent. of the fleas of the three species. *X. astia* was more common in Bombay than in Coonoor or Ootacamund while *brasiliensis* was more common in the latter places than in Bombay.

### (*c*) Assistance and Advice rendered.

Examination of rats for plague.

8. The Health Department of the City of Bombay sent daily for examination all rats found dead or caught alive within the bounds of the Municipality. As a note is received with the rats indicating where each rat has been found, it is possible to inform the Health Officer of the City where plague-infected specimens have been picked up, he was thus able to adopt suitable measures to observe and check the progress of the disease throughout the city. During the year 644,241 rats were received at the Laboratory from the Health Department; 342,182 were alive when received, and 302,059 were dead; of the latter 210,080 were examined and among them 12,530 were found to be plague-infected.

The following table shows the progress of plague each half month among men and rats in Bombay. The figures which refer to men record the number of deaths from plague each half month. The figures showing the progress of the disease in rats are given separately for *Mus rattus* and *Mus decumanus*. These figures have been calculated from the number of rats found infected at the examination made at the Laboratory on every day of the week except Sundays and holidays; from the actual figures obtained on the days on which examinations were made a figure has been calculated for all the days of each half month and these figures are recorded:

*Return of rats examined during the year 1914.*

| | Human plague mortality. | | Plague-infected *rattus*. | | Plague-infected *decumanus*. | |
|---|---|---|---|---|---|---|
| | Number of deaths from plague. | Percentage above and below mean for the year. | Figures calculated for each half month. | Percentage above and below mean for the year. | Figures calculated for each half month. | Percentage above and below mean for the year. |
| 1914. | | | | | | |
| 1st to 15th January ... | 20 | − 83 | 93·7 | − 22 | 397·5 | − 23 |
| 16th to 31st January ... | 37 | − 69 | 139·4 | + 16 | 649·1 | + 26 |
| 1st to 15th February ... | 45 | − 63 | 188·7 | + 57 | 792·5 | + 54 |
| 16th to 28th February ... | 69 | − 43 | 211·5 | + 76 | 767·0 | + 49 |
| 1st to 15th March ... | 158 | + 31 | 383·2 | +219 | 1,215·0 | +136 |
| 16th to 31st March ... | 301 | +149 | 353·2 | +194 | 1,323·0 | +157 |
| 1st to 15th April ... | 492 | +307 | 418·7 | +248 | 1,730·0 | +235 |
| 16th to 30th April ... | 639 | +428 | 376·2 | +213 | 1,843·8 | +257 |
| 1st to 15th May ... | 597 | +393 | 266·5 | +122 | 1,346·5 | +161 |
| 16th to 31st May ... | 225 | + 86 | 126·8 | + 5 | 793·8 | + 54 |
| 1st to 15th June ... | 107 | − 12 | 68·1 | − 43 | 365·8 | − 29 |
| 16th to 30th June ... | 38 | − 69 | 33·7 | − 72 | 198·7 | − 61 |
| 1st to 15th July ... | 42 | − 65 | 18·5 | − 85 | 156·9 | − 70 |
| 16th to 31st July ... | 35 | − 71 | 20·6 | − 83 | 153·1 | − 70 |
| 1st to 15th August ... | 21 | − 83 | 34·1 | − 72 | 132·3 | − 74 |
| 16th to 31st August ... | 32 | − 74 | 30·7 | − 74 | 122·7 | − 76 |
| 1st to 15th September ... | 20 | − 83 | 16·2 | − 87 | 87·5 | − 83 |
| 16th to 30th September ... | 12 | − 90 | 12·3 | − 90 | 114·5 | − 78 |
| 1st to 15th October ... | 8 | − 93 | 30·0 | − 75 | 64·6 | − 87 |
| 16th to 31st October ... | 2 | − 98 | 24·0 | − 80 | 53·3 | − 90 |
| 1st to 15th November ... | 1 | − 99 | 17·5 | − 85 | 22·5 | − 96 |
| 16th to 30th November ... | 5 | − 96 | 10·4 | − 91 | 15·0 | − 97 |
| 1st to 15th December ... | 3 | − 98 | 3·5 | − 97 | 12·7 | − 98 |
| 16th to 31st December ... | 1 | − 99 | 8·0 | − 93 | 18·7 | − 96 |

PART II.

## Work of the Laboratory as the Provincial Bacteriological Laboratory.

### (*a*) Routine Work.

### I.

*Examinations of Pathological Fluids and Discharges, Waters, etc.*

Pathological work done at the Laboratory.

9. A large number of specimens were received for examination.

I.—Blood Sera—

Of the 269 specimens examined, 68 gave a positive agglutinative reaction to B. typhosus; 2 to B. paratyphosus A; and one partially to B. paratyphosus B in dilutions of 1—20.

Blood Sera for the Wassermann reaction—

This test was performed in 240 cases, of which 96 were positive.

II.—Blood Smears—

Of 468 specimens examined, malarial parasites were present in 167 cases.
Differential leucocyte counts were made 13 times.
4 specimens of blood for Filaria were examined with negative result.
8 specimens were examined for the Micrococcus melitensis with negative results.
B. pestis was present in one case out of the 7 cases examined.
Blood cultures were made 42 times.

III.—Sputa—

125 specimens were examined; T. B. was found in 29 cases.

IV.—Throat Discharges—

22 specimens were examined for Diphtheria, of which 1 showed the presence of Bacillus diphtheriæ, and one an organism resembling B. Diphtheriæ.

V.—Pus—

9 specimens were examined; 1 showed the presence of gonococci.

4 slides were examined for the presence of Treponema pallida.

2 smears of pus were examined for B. pestis.

VI.—Fæces and Urine—

17 specimens of fæces and 79 specimens of urine were examined for various pathological conditions.

VII.—Foodstuffs—

2 specimens were examined.

VIII.—Milk—

5 specimens of milk were examined.

IX.—Water—

25 specimens of water were examined bacteriologically.

X.—Rats—

20 dead rats were received from outstations, of which 6 were plague-infected.

XI.—*Post mortem* examinations were held on 124 animals received for the most part from the Zoological Gardens of Bombay to ascertain the cause of death.

XII.—6 snakes, 2 squirrels, 6 mosquitos, 2 intestinal worms and 1 fly were identified.

XIII.—Miscellaneous specimens—

1 specimen from abdominal fluid; 3 of cerberospinal fluid; 1 of ear discharge; 1 swab from uterine discharge; 2 specimens for cholera; 1 trypansome; 1 surra and 1 anthrax were examined.

## II.

### *Diagnosis of Rabies.*

Examination of dogs or rabies.

10. The examination of brains of dogs and other animals for the diagnosis of rabies was performed in 120 cases.

The brains were received from the following places :—

| | | | |
|---|---|---|---|
| Bombay— | | | |
| Through the Bombay Veterinary College | ... | ... | 71 |
| „ the Bombay Municipality | ... | ... | 1 |
| „ the Bombay Port Trust | ... | ... | 1 |
| „ the Bombay Police | ... | ... | 5 |
| „ private owners | ... | ... | 8* |
| Colaba ... ... | ... | ... | 3 |
| | | | 89 |
| Outstations— | | | |
| Dhárwár ... ... | ... | ... | 5 |
| Násik ... ... | ... | ... | 3 |
| Bándra (bullock's) ... ... | | ... | 1 |
| Ahmedabad ... ... | ... | ... | 3 |
| Khandála ... ... | ... | ... | 1 |
| Ahmednagar (horse) ... | ... | ... | 1 |
| Surat ... ... | ... | ... | 5 |
| Lonand ... ... | ... | ... | 1 |
| Belgaum ... ... | ... | ... | 1 |
| Dhulia ... ... | ... | ... | 1 |
| Jalgaon ... ... | ... | ... | 2 |
| Andheri ... ... | ... | ... | 3 |
| Poona ... ... | ... | ... | 3 |
| Cambay ... ... | ... | ... | 1 |
| | | | 31 |
| | Total | ... | 120 |

* One was from a cat.

Of the 120 brains which were received, nine arrived in such a condition that no examination could be made; thirty-four showed no evidence that they had been obtained from rabid animals. In the case of six brains although no definite "negri bodies" were found structures resembling these bodies were observed which raised the suspicion that the brains had been obtained from rabid animals. In seventy-one cases sections of the brains showed the presence of "negri bodies", these brains had apparently been removed from rabid animals.

## III.

### *Patholcgical tissues received for diagnosis.*

Classification of morbid tissues sent for examination.

11. During the year sections were cut and specimens examined in 339 cases. The following table shows the tumours and other morbid tissues examined at the Laboratory during the year 1914 :—

| | | | | |
|---|---|---|---|---|
| I.—Tumours— | | | | |
| A.—Non-malignant tumours— | | | | |
| 1. Ichthyotic warts | ... | ... | ... | 1 |
| 2. Papilloma | ... | ... | ... | 5 |
| 3. Villous papilloma | ... | ... | ... | 1 |
| 4. Cystoma | ... | ... | ... | 8 |
| 5. Adenoma | ... | ... | ... | 1 |
| 6. Fibro-adenoma | ... | ... | ... | 6 |
| 7. Adeno-myxoma | ... | ... | ... | 1 |
| 8. Lymph-adenoma | ... | ... | ... | 2 |
| 9. Lymphangioma | ... | ... | ... | 2 |
| 10. Hæmangioma | ... | ... | ... | 3 |
| 11. Fibroma | ... | ... | ... | 11 |
| 12. Soft fibroma | ... | ... | ... | 1 |
| 13. Fibro-myxoma | ... | ... | ... | 6 |

| | | | | |
|---|---|---|---|---|
| 14. | Myxoma | | 1 | |
| 15. | Fibro-neuroma | | 1 | |
| 16. | Fibro-lipoma | | 2 | |
| 17. | Lipoma | | 2 | |
| 18. | Chondroma | | 1 | |
| 19. | Myoma | | 1 | |
| | | | | 56 |
| B.—Malignant Tumours— | | | | |
| (*a*) 1. | Epithelioma squamous-celled | | 32 | |
| 2. | Epithelioma basal-celled | | 1 | |
| 3. | Adeno-carcinoma | | 6 | |
| 4. | Papillary adeno-carcinoma | | 1 | |
| 5. | Carcinoma simplex | | 8 | |
| 6. | Medullary or encephaloid carcinoma | | 6 | |
| 7. | Scirrhus carcinoma | | 8 | |
| | | | | 62 |
| (*b*) 1. | Round-celled sarcoma | | 14 | |
| 2. | Spindle-celled sarcoma | | 13 | |
| 3. | Mixed-celled sarcoma | | 4 | |
| 4. | Myeloid sarcoma | | 2 | |
| 5. | Myxo sarcoma | | 1 | |
| 6. | Myxo chondroma | | 1 | |
| 7. | Melanoma | | 5 | |
| 8. | Glioma of retina | | 1 | |
| 9. | Endothelioma including mixed parotid tumours | | 11 | |
| | | | | 52 |
| II.—Granulomata— | | | | |
| 1. | Tubercular | | 45 | |
| 2. | Syphilitic | | 9 | |
| 3. | Other Granulomata | | 8 | |
| | | | | 62 |
| III.—Inflammatory Processes, etc.— | | | | |
| 1. | Chronic inflammatory condition | | 7 | |
| 2. | Chronic abscess | | 1 | |
| 3. | Anthrax | | 2 | |
| 4. | Uterine scrapings (Endometritis) | | 6 | |
| 5. | Inflammatory uterine (Glandular erosion) | | 1 | |
| 6. | Guineaworm | | 1 | |
| 7. | Gangrene (acute) | | 2 | |
| 8. | Leprosy | | 1 | |
| 9. | Mycetoma | | 2 | |
| 10. | Non-malignant (other pathological conditions) | | 7 | |
| 11. | Chronic plague | | 1 | |
| 12. | Chronic piles | | 1 | |
| 13. | Polypus | | 1 | |
| 14. | Typhoid ulceration | | 1 | |
| 15. | Ulcers | | 4 | |
| 16. | Pathological conditions of various organs | | 34 | |
| | | | | 72 |
| IV.—Tissues in which nothing abnormal was noted in which no diagnosis was arrived at or diagnosis impossible | | | | 33 |
| V.—Tissues received and diagnosis was impossible because of poor preservation or for some other reason | | | | 2 |

## IV.

### *Snakes.*

Snakes.

12. Poisonous Indian snakes are kept in the Laboratory for the purpose of obtaining a supply of venom for the manufacture of anti-venomous serum. The following table shows the number of snakes received during the year :—

| Place. | Cobra. | Russell's viper. | Echis. | Krait. | |
|---|---|---|---|---|---|
| Bombay Presidency ... | 15 | 27 | 280 | 2 | 324 |
| Central Provinces ... | 4 | 1 | ... | 1 | 6 |
| Rajputana ... | 4 | ... | ... | ... | 4 |
| Total ... | 23 | 28 | 280 | 3 | 334 |

## (*b*) Research Work.

### I.

Research in connection with Guineaworm Disease.

13. The study of guineaworm disease was continued throughout the year by Major Glen Liston, I. M. S., and Dr. Turkhud, M.B., C.M. (Ed.). An interesting investigation into the prevalence of the disease in the town of Ránebennur was made with the assistance of the Honourable Mr. Venkatesh Shrinivas Naik.

The town of Ránebennur has a population of 13,972 persons. At the time of our visit to the town there were 203 cases of guineaworm disease, that is to say, 1·45 per cent. of the population were suffering from the disease.

One hundred and twenty-eight males and 75 females were affected, they lived in 150 houses. The majority of the houses contained single cases, but 25 houses had 2 cases, 1 house had 3 cases, 3 houses had 4 cases, 1 house had 6 cases, and 1 had 8 cases. The large majority of the sick had one worm only; forty-four cases had two worms; eleven had three worms; seven had four worms; four cases had five worms; and four cases had nine worms. Single cases had six, seven, eight, ten and twenty-four worms each.

The water-supply of the town is derived from fifteen sources, *viz.*, eleven step-wells, two tanks and two draw-wells. All the persons who suffered from the disease obtained water either from the step-wells or tanks. Those who obtained their drinking water from the draw-wells were free from the disease.

Years have passed in a fruitless discussion of various plans to improve the water-supply of this town. All the schemes so far submitted have been too costly for the Municipality. Meanwhile the disease continues although much could even now be done to improve the existing sources of water-supply at small cost.

With the assistance of Mr. V. A. Dabholkar the prevalence of guineaworm disease in the village of Desai was investigated. This village has a population of 159 persons living in 39 houses. The sole water-supply of this village is a small well which becomes almost dry in the hot season so that at this time of the year the supply of water cannot be more than half a gallon per head of the population.

The population of the village was made up of 67 males and 62 females. Eight of the females had come to the village recently, they had married men resident in the village. There were also 30 children in the village. Excluding from consideration the children, we find that forty males and 25 females had been attacked by the disease at some time or other during their stay in the village. Twenty-seven males and thirty-seven females who had been long resident in the village and who used water from the same source as the other villagers never suffered at any time from the disease; these persons appeared to be immune to the disease. No explanation can be offered for this remarkable immunity.

If the eight females who had recently come to the village and the 30 children be excluded from consideration, then fifty-one persons or forty-two per cent. of the population who had been resident in the village for a number of years never suffered from the disease while 70 or 58 per cent. suffered at one time or another. The susceptibility to infection of those attacked by the disease seemed to vary for, of the 70 persons attacked 34 or 48·5 per cent. suffered almost every year, 15 or 21·4 per cent. had the disease often, 21 or 30 per cent. suffered from the disease once, twice, or thrice.

As in the town of Ránebennur so in the village of Desai, for some unexplained reason, the males suffered more frequently from the disease than the females, 60 per cent. of the former against 40 per cent. of the latter.

The figures obtained during this investigation show that on an average 24 men and 16 women are incapacitated for work for at least one month every year because of guineaworm disease in this village.

The following estimates for improving the water-supply of this village were prepared :—

*No. 1—Capital Cost.*

| | Rs. |
|---|---|
| Deepening the well 10 ft. ... ... ... | 130 |
| Repairs to masonry wall ... ... ... | 40 |
| Reinforced concrete cover ... ... ... | 100 |
| Cast iron man-hole ... ... ... | 30 |
| Providing and fixing two Myer's pumps ... ... | 150 |
| Providing and fixing 1½" iron piping ... ... | 50 |
| Two iron cisterns 4 feet cube, capacity 400 gallons with 4 taps each ... ... ... ... | 250 |
| Total Rs. ... | 750 |

*No. 2—Annual Cost.*

| | Rs. |
|---|---|
| Wages of one man for pumps at Rs. 10 per mensem ... | 120 |
| Repairs to plant per annum ... ... | 30 |
| Interest on capital Rs. 750 at 6 per cent. ... ... | 45 |
| Depreciation at 5 per cent. for masonry ... ... | 9 |
| Depreciation on plant at 10 per cent. ... ... | 45 |
| Total Rs. ... | 249 |

*A capital expenditure of seven hundred and fifty rupees and an annual recurring expenditure of two hundred and forty-nine rupees would ensure the complete disappearance of guineaworm disease from this village.*

The improvement of the water supply of this village is a business proposition. We can estimate that the loss of wages of twenty-four men at six annas a day for one month every year will amount to Rs. 270, and of sixteen women at four annas a day will amount to Rs. 120 ; while the wear and tear on the ropes and buckets used at present for drawing water by each family may be estimated at Rs. 2 per family per annum (39 families) or Rs. 78 for the whole village.

There is thus an annual loss in this village due to the present method of drawing and using water which, if expressed in money, would amount to about Rs. 468 per annum, but it has been shown that for an expenditure of Rs. 249 per annum guineaworm disease could be completely abolished from this village, not only would the villagers be saved the pain suffering and deformity attendant on this disease but they would make a net gain, if estimated in cash, of Rs. 219 per annum. I desire to draw the attention of Government to this subject in connection with their schemes for rural sanitation.

## II.

14. The study of tuberculosis as it occurs in India was much interrupted during the year by the transfer of officers from the Laboratory to active service in connection with the war. This work was successively in the charge of Major Gloster, Captain Taylor and Captain Stevenson. Despite these changes in the staff engaged on the work considerable progress was made during the year. Dr. Soparkar, M.D., voluntarily took up the investigation on the departure of Captain Stevenson.

In the annual report for the year 1913 mention was made of an inquiry into the prevalence of bovine tuberculosis in this part of India. The importance of this investigation is obvious in view of the fact that great efforts are being made to apply to this country the rules and regulations adopted in Europe and America for the control of the milk and meat supply. These rules in Britain and America have been framed chiefly because of the prevalence of bovine tuberculosis in these countries and because of the danger of communicating bovine tuberculosis to human beings.

Our early investigations in Bombay showed that tuberculosis in cattle is a comparatively rare disease. Recognising, however, that our opportunities for obtaining material from infected cattle were not as satisfactory as might be, an endeavour has been made to study the question from another point of view, *viz.* : in how many cases of human tuberculosis can bacilli of bovine type be isolated ?

Observations in Britain and America have shown that a fair proportion of young persons suffering from tubercular lymphatic glands are infected by the bovine type of tubercle bacillus. Working on these lines some progress has been made in the investigation of this problem. Fifteen strains of tubercle bacilli have so far been isolated and examined. Of these one was from a sputum, and one from tubercular axillary glands, while the remainder were from tubercular cervical glands. Classifying these strains isolated from cervical glands according to the age of the patients from which they were isolated, 4 cases were from adults of over sixteen years of age, and 8 cases were from children between five and sixteen years. In one case the age of the patient was not obtained. The importance of this classification arises from the fact that the majority of workers at this problem in Britain and America have found that tubercle bacilli of the bovine type are most frequently isolated from children (from 33 to 77 per cent. of cases under sixteen), and are comparatively rarely found in adults suffering from tubercular cervical adenitis. In not one of our cases has a strain resembling the bovine type been met with.

Many difficulties have been encountered in carrying on this investigation but these have been overcome and need not be mentioned here.

Doctor Soparkar has made some interesting observations on the vitality of the tubercle bacillus outside the body. He has shown that when sputum is exposed to the direct action of the sun in Bombay, the bacilli remain alive for six hours but are dead in eight hours. When tuberculous sputum is exposed in a well-lighted room but protected from the direct action of the sun, tubercle bacilli can be isolated from it alive six days after exposure but all the tubercle bacilli were dead in eight days. Tubercular sputum when kept in a dark cupboard, although completely dessicated over lime, still contained living bacilli six months after it had been deposited.

These observations have an important bearing on the methods adopted for the prevention of this disease. They show that sun-light is an important agent in destroying tubercle bacilli and that dark rooms in which the sputum of tubercular patients has been deposited may remain infected for months.

Other experiments which have a bearing on the vitality of the bacillus outside the body of man and animals and on the manner in which the tubercle bacilli may gain an entrance into the body of healthy animals are in progress. Full details of these experiments will be published in due course.

## III.

15. A number of cases of "rat-bite" disease have come under observation. No definite causative organism has been observed or isolated from these cases; but the intravenous injection of "Salvarsan" has rapidly cured the most obstinate cases of this distressing fever although the patients failed to respond to other forms of treatment.

### (*c*) Assistance and Advice rendered.

16. Captain Taylor, I. M. S., was deputed to Aden to make an inquiry into the existing water supply of that town and to ascertain what other sources of supply might be made available. The details of this inquiry have been published by Government in the form of a "Note on the Aden Water Supply" so that further mention of it need not be made here, other than to state that this inquiry has shed much light on the quality of the available supplies and much money might have been saved had the investigation preceded the undertaking of any work connected with the water supply.



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17. The Laboratory has been able to assist the Medical Department of the Field Forces in a number of ways, for example, in the manufacture and supply of sealed tubes of Iodine and Potassium Iodide for the preparation of antiseptic lotion in the field. A large number of doses of typhoid and cholera vaccine and curative sera have also been supplied to the Forces. Autogenous vaccines have been prepared for the wounded under treatment in the Bombay Military and War Hospitals.

### (*d*) EDUCATIONAL.

18. Lectures and demonstrations were arranged to instruct a number of school teachers and scholars in the causes and prevention of disease. Lantern slides and photographs have been supplied to a few persons and societies who specially desired to have these means of instructing the public. The facilities available in the Laboratory for preparing these slides and pictures are, by no means adequate. Many District Sanitary Associations have appealed to us for help which frequently has to be refused because we are unable to cope with the demand.

19. Some progress was made with the plans and buildings for the proposed School of Research in Tropical Medicine.

20. The satisfactory working of this institution is due mainly to the loyal support and willing help I have received from the whole staff at all times.

W. GLEN LISTON, M.D., D.P.H.,
Major, I. M. S.,
Director, Bombay Bacteriological Laboratory.

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